

Making Paper

Background

Paper was first made by wasps. Many innovations are influenced by what we find in nature. Paper was first produced by humans in China, around 105 Ad. Ts'ai Lun, a court official, figured out a way to make paper by shredding the bark of a mulberry tree and mixing it with scraps of linen and hemp. He added water and beat the mixture into pulp. He made a frame of bamboo, covered the bottom with cloth, and dipped the frame into the pulp. Then he let it dry until he could pull it off the frame in a sheet.

The cell walls in most plants are cellulose, the part of the plant from which paper is made. Most paper today is made from the cellulose of fast-growing trees like the loblolly pine grown on tree plantations in southeastern Oklahoma. Agricultural researchers are also experimenting with making paper from other, even faster growing sources of cellulose, like the debris left over after harvesting crops like wheat and corn.

To make paper from a tree, the bark is stripped from the trunk, then the trunk is chopped into small chips. The chips are cooked at a high temperature with chemicals and placed on a conveyor belt that travels through several machines. The machines wash the pieces several times to create clean pulp. More machines flatten and break apart the lumpy fibers. The paper is then pressed and dried into smooth, uniform sheets and sold in large rolls called reams.

Trees are a renewable resource, which means when we cut them down we can grow more. But cutting too many of them at once can cause soil to erode. The soil washes into waterways and clogs rivers and streams. Trees also need plenty of space to grow.

Many trees today are grown on farms just to provide trees for paper and other wood products. In northeastern Oklahoma there are plantations of loblolly pine grown for that purpose. Loblolly pine is a kind of tree that grows very quickly. In some parts of the south, farmers have stopped growing crops like cotton and let their land go back to pine forest, because selling trees is more profitable than raising traditional crops.

Today people in the US use about 24 times as much paper as people in China, the country where paper was first produced. The US is the largest producer and consumer of paper and paper products in the world. In 1990 each American used about 663 pounds of paper. By contrast, residents of China only used about 28 pounds each.

Most of the garbage that goes into landfills is paper. Even though paper is biodegradable, it cannot break down if there is too much in one

P.A.S.S.

Grade 4

Visual Arts—1.2,3,4; 2.1,3;
3.1,2,3,4,5; 4.2,3

Math Process—1.1,2,3; 2.1,3;
3.2,3; 4.4; 5.1,2

Math Content—1.2; 2.2a;
4.1ac; 5.1ab,2

Life Science—3.1

Earth Science—3.1

Writing—2.1,2,3,4,6,7

Visual Literacy—1.2

Grade 5

Visual Arts—1.2,3,4; 2.1,3;
3.1,2,3,4,5; 4.2,3

Math Process—1.1,2,3; 2.1,3;
3.2,3; 4.4; 5.1,2

Math Content—2.1c; 5.1b,2a

Social Studies—7.2,5

Life Science—2.1

Earth Science—3.1

Writing—2.1,2,3,4,6,7

Visual Literacy—1.2

Grade 6

Visual Arts—1.2,3,4; 2.1,3;
3.1,2,3,4,5; 4.2,3

Math Process—1.1,3; 4.1;
5.3,4

Math Content—4.2,3; 5.1,2

Social Studies—3.2

Writing—2.1,2,3,4,6,7

Visual Literacy—1.2

Materials

Materials needed for making paper are listed on the instruction sheet

two trash containers

Vocabulary

biodegradable—capable of being decomposed by natural processes

bark—the outer covering of the woody stems, branches, roots and main trunks of trees and other woody plants as distinguished from the inner wood

cell—the smallest structural unit of an organic structure, plant or animal

cellulose—an inert, complex, carbohydrate which makes up the bulk of the cell walls in plants

consumer—someone who acquires goods or services

crate—a square or rectangular box used to carry farm products or objects

erode—to wear away by or as if by the action of water, wind, or glacial ice

felt—a fabric made from wool or animal hair by pressing, heating, or treating the fibers with chemicals

fiber—one of the elongated, thick-walled cells that give strength and support to plant tissue

(Continued on next page.)

area. The volume of paper in landfills prevents it from ever having contact with soil. Soils hold the microorganisms necessary to help break it down.

Recycling paper and using products made from recycled paper will help keep our landfills from filling up too fast. Then we can continue using our land for other purposes, like growing food.

Visual Arts

1. Divide students into groups of four or five. Provide each group with materials to make paper. Demonstrate the process, using the instructions included with this lesson.
2. Have students use the paper they made for invitations or holiday cards. Dress the paper up by adding perfumes.

Math

1. Bring two empty trash containers to class. Label one “white paper” and the other one “colored paper.”
 - Students will predict how much paper they think they use in one day. Record estimates for each student. Ask how much they think the entire class uses in one day. Record estimates.
 - Explain that for one day each student will sign or initial every sheet of paper he/she throws in the trash. All the white paper will go in the trash labeled “white paper,” and all the colored paper will go in the trash can labeled “colored paper.”
 - At the end of the day have students estimate how many sheets of paper are in each recycling box. Have students estimate the number of sheets of paper he or she personally used. Check the results by counting and recording this information on the board for everyone to view.
 - Have students estimate the length of the papers if placed end to end in the hallway. Have students line the hallways with the paper and measure to check their estimates.
 - Have students create bar graphs showing the total amount of paper used by the class in one day. Then have each student create a bar graph showing how much paper he or she used.
2. Have students formulate math problems based on the information gathered in Activity 1. (e.g., Who uses more paper— girls or boys? If everyone used 25 percent less paper, how many sheets would be in the trash in one day? How much paper would it take to cover the entire classroom floor? How much wadded up paper would it take to fill the entire classroom?)
2. Bring a clear container to class, and fill it with candy, pencils, erasers, etc. Leave the container on display for the month, and have students estimate the number of objects inside. Count the contents of the container as a class. The person with the closest estimate wins what’s in the container. Continue for several months, always using the same container. Have students create graphs to keep track of their estimates, so they can see if their estimates improve with time.

Social Studies

1. Read and discuss background material.
 - Brainstorm reasons people in America use more paper than people in China.
 - Ask students why we should be concerned that our landfills are filling up (loss of land for agricultural and other uses and the high cost to cities and counties of building and maintaining environmentally-safe landfills).
2. Invite the city or county official responsible for waste management in your area to come to your class and discuss some of the costs involved with maintaining landfills.
3. Plan a field trip to a local newspaper or printing office so students can see paper being used in a manufacturing setting.
4. Encourage your class to start a schoolwide recycling campaign. Have students decorate recycling boxes with shelf paper or some other adhesive-type paper, label the boxes, and distribute them to other classes. The students should be responsible for collecting the recyclable paper twice a week and bundling it for the recycling center. Enlist the help of three or four parents to take turns delivering the recyclables to the recycling center. Have students count papers from each classroom and use bar graphs to find which classrooms are most aggressive in their recycling efforts. Display the graph where classmates and visitors can view the results.
5. Do without trash cans in your room for one day.
 - Instruct students to crumple their paper and toss it on the floor if they need to throw it away.
 - At the end of the day, discuss the amount of paper on the floor.
 - Have students inspect some of the discarded paper and discuss how much was wasted and how much was used as much as possible.
 - Brainstorm to find ways to cut down on paper use in the classroom.
 - Have everyone help pick up the paper before dismissing class for the day.

Science

1. The volume of paper in landfills prevents it from ever having contact with soil. Soils hold the microorganisms necessary to help break paper down. Demonstrate this for students by filling one gallon jar with shredded newspaper and another gallon jar with half soil and half newspaper. Keep the contents of each jar moist for about a week. Students will observe which jar of paper decomposes faster.

Extra Reading

Nivola, Claire A., *Planting the Trees of Kenya: The Story of Wangari Maathai*, Farrar, Straus and Giroux, 2008.

Vocabulary (Cont.)

hemp—an annual herb which yields hashish, bird seed and hemp fiber, used in making rope

linen—a woven fabric made from the inner bark of the flax plant

loblolly—a mud hole

loblolly pine—a pine tree of the southeastern United States, having strong wood used as lumber and for paper pulp

microorganism—an animal or plant too small to be seen without a microscope

producer—someone who creates something by mental or physical effort

pulp—a product obtained from digesting wood in a slightly alkaline or neutral sodium sulfite cooking liquor

ream—a large roll of paper that has been pressed

renewable—capable of being replaced by natural ecological cycles or sound management procedures, e.g., water, wildlife, forests, and grasslands

resource—a usable stock or supply

trunk—the main wood axis of a tree

Name _____

Making Paper

The Pulp

1. Tear the used tissue or newsprint into pieces the size of the end of a crayon.
2. Measure 1/2 cup of the torn paper and two cups of hot water into a bowl or blender.
3. Beat the mixture with a blender or egg beater.
4. Mix in two teaspoons of instant starch to strengthen the paper. The pulp mixture should now be thick.

Optional: Decorate the pulp after it comes out of the blender by laying tiny leaves, flowers or other flat objects on the pulp.

The Process

1. Place the egg crate with the vinyl screen into the bottom of the 2-inch deep pan.
2. Add water to the 2-inch deep pan.
3. Pour the pulp mixture into the 2-inch deep flat pan and gently move it around until most of the pulp is floating evenly at the top.
4. Carefully lift the egg crate plastic with the screen. Try to hold the egg crate with the palm side of your hand. Finger marks will show. Hold it level, and let the excess water drain. Place pencils across the corners of the pan supporting the egg crate and screen.
5. Drop inclusions onto the damp weak pulp. Place name on pulp.
6. Count to 50, allowing the pulp to drain.
7. Move the crate, with screen, to the cookie sheet pan.
8. Place another screen on top of the fresh pulp.
9. Sponge off the sandwiched pulp. Top to bottom: screen, pulp, screen, egg crate, cookie sheet.
10. Use a flat firm hand when sponging off the sandwiched pulp.
11. Slide the screen, pulp, screen to the newspaper.

Materials Needed

- 2-inch deep pan
- vinyl screen (doesn't poke fingers)
- cut fluorescent light egg crate to fit pans (use a band saw or hack saw)
- borrow a large cookie sheet from the cafeteria
- sponges
- 1 gallon can for each group
- 1 egg beater for each group
- 1 rolling pin
- dry iron
- newspaper
- 1 felt square for each group (felt doesn't fade)
- used tissue or newsprint
- instant starch
- 1 inch by 1 inch pieces of paper for students to write their names with a pencil

Inclusions: fine threads from fabric, pansy petals, marigold seeds, tiny pieces of colored tissue

waterbase markers can be used to add color

12. Beginning at one corner, gently lift one corner of the screen. Thump the screen to release the sponged pulp. As the pulp releases pull the corner of the screen toward the opposite corner. You should be gently rolling one corner back toward the opposite corner.
13. You should have sponged off pulp, screen, and newspaper lying in a stack in front of you. Place the felt square on top of the pulp, screen, newspaper sandwich.
14. Turn this sandwich over so the newspaper is on top. Remove the newspaper. Remove the screen. You should be looking at the pulp. Place another piece of felt on top of the pulp.
15. Use the rolling pin to ROLL (do not push the rolling pin) across the sandwich of felt, pulp, felt. The rolling pin will remove more water, making the pulp stronger.
16. Carefully peel the felt back from the pulp.
17. Place a piece of smooth 12-inch by 12-inch fabric (old sheet) on top of pulp.
18. Gently turn the 12"x12" fabric, pulp, felt over so the felt is up. Peel the felt off as before.
19. Place the piece of wet paper in a quiet area to dry for 24 hours. (Leave the return air blowing tonight).
20. After drying, place the curled papers with names still inbedded in a stack.
21. Place a stack of six encyclopedias or heavy books on top of the dried paper.

